Determination of the Molar Volume of a Gas

Introduction

Equal volumes of gases contain equal numbers of gaseous particles. So how much volume would 6.02×10^{23} gaseous particles occupy at standard temperature and pressure? Using a known amount of Mg in reaction with HCl, you will be able to make this determination.

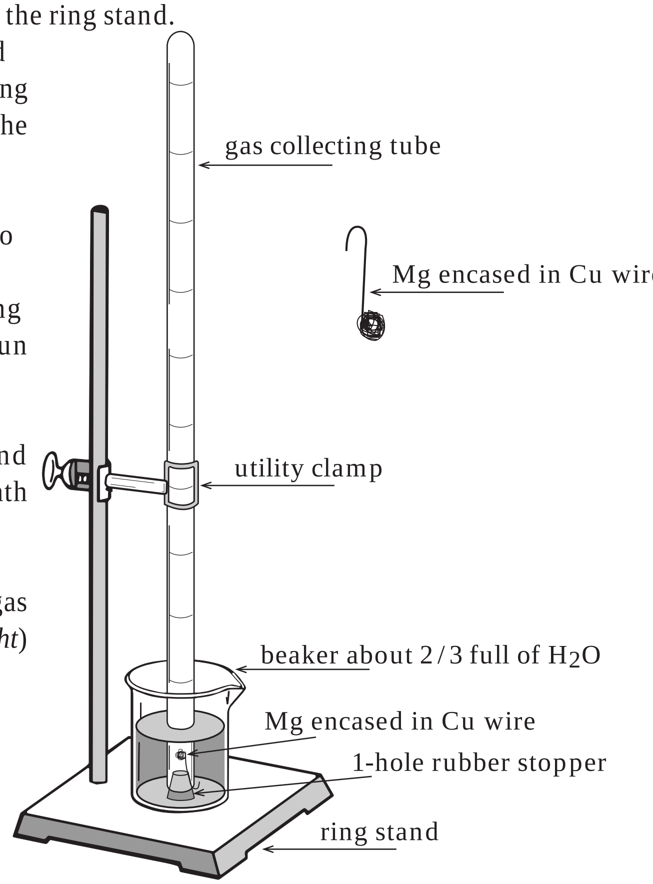
Procedure

1. Put on goggles. Using a ruler, measure the length of your magnesium ribbon to the nearest 0.1 cm and record.
2. Roll the Mg into a small ball and wrap a piece of fine Cu wire (~ 25 cm or so) around the rolled Mg to encase it. As you wrap the Mg, leave about 4-5 cm of Cu wire extended from the "case" as a "tail." Bend the last cm of the Cu wire tail over to form a hook. See illustration.
3. Place the utility clamp on the ring stand. Fill the large beaker about 2/3 full of room temperature tap H_2O. Use your thermometer and adjust the hot and cold H_2O faucets as needed.
4. Record room temperature and barometric pressure.
5. Secure gas measuring tube in utility clamp. The open end should be on top and the bottom should be about 15 cm above the base of the ring stand.
6. Measure 10 mL of 6.0 M HCl in the graduated cylinder and carefully pour into the gas measuring tube. Without disturbing the HCl, slowly pour H_2O into the gas measuring tube until the H_2O comes to the brim of the tube. Place the beaker of H_2O under the gas measuring tube on the base of the ring stand.
7. Hook the Cu wire over the top of the gas measuring tube so that the encased Mg is in the H_2O in the tube. Insert the 1-hole rubber stopper securely in the top of the gas measuring tube. A little H_2O should be displaced by the stopper and run down the outside of the tube into the beaker underneath.
8. Cover the hole in the stopper with your finger while your partner loosens the utility clamp. Quickly invert the tube and place the stoppered end of the gas measuring tube underneath the H_2O level in the beaker. Secure the tube in the utility clamp with the stopper about $^1/_2$" above bottom of beaker. Observe the dense HCl move down through the H_2O in the gas measuring tube to react with the Mg. *(see illustration to the right)*

(continued on back side)

Materials

- gas measuring tube
- ring stand
- utility clamp
- large beaker (400 or 600 mL)
- graduated cylinder (10 mL)
- thermometer
- barometer
- 1-hole rubber stopper (to fit gas measuring tube)
- large deep container of H_2O
- ruler
- magnesium ribbon
- fine copper wire
- 6.0 M HCl



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Procedure *(continued from front side)*

9. Wait about 5 minutes after the reaction has stopped and then tap the tube to dislodge any bubbles that may have formed.
10. Cover the hole in the stopper with your finger while your partner loosens the utility clamp. Quickly walk (stopper end down, but sealed with your finger!) to the large container of H_2O. Place the stoppered bottom of the tube under the H_2O level in the large container. Remove your finger that is sealing the stopper. Raise or lower the tube until the H_2O level in the tube is the same as the H_2O level in the container. Record the volume of collected gas.
11. Reseal the stopper with your finger, remove from the large container, and quickly turn the gas measuring tube right side up. Dispose of the excess HCl and clean up as directed by your teacher. Wash your hands.

Data Table

Mass of 1.00 m of Mg ribbon (given by teacher)	_________	g
Length of Mg ribbon	_________	g
Room Temperature	_________	°C
Barometric Pressure	_________	mm Hg
Volume of Collected Gas	_________	mL

Analysis and Calculations

1. Write the balanced equation for the reaction.
2. Calculate the mass of Mg used.
3. Calculate the moles of Mg used.
4. Using your balanced equation, determine how many moles of H_2 you produced.
5. Convert barometric pressure from mm Hg to kPa.
6. Using Dalton's Law, find the partial pressure of the H_2 collected over H_2O.
7. Using the combination of Boyle's and Charles' gas laws, determine what your volume of H_2 would be if collected at standard temperature (273° K) and standard pressure (101.3 kPa).
8. Convert your standard gas volume to liters.
9. You produced far less than a mole of H_2. Using a ratio proportion, calculate the volume that 1 mole of gas would occupy at standard temperature and pressure.